Preliminary

Phenolic Resin Impregnated Veneer/Wafer Overlaid Particleboard

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Introduction

The world population is increasing at an alarming rate. Due to the increased rate of human activities, forest resources are being exhausted. Therefore, the effective utilization of lesser-used forest resources, wastes from forest industries should be a vital concern. These wood resources have already been used for making particleboard, waferboard and OSB as alternatives for plywood. However, the specific mechanical properties are somehow inferior to plywood. Lamination structures can be applied to wood based panels for improving the mechanical properties, for example, veneer-overlaid and hardboard-overlaid particleboard are produced commercially[1)].

In our previous study[2)], a new method for deforming phenolic resin impregnated wood well at lower pressing pressure was developed. We found that phenolic resin acts as a plasticizer and causes significant softening of the cell wall resulting in collapse at lower pressing pressure. Pressure holding causing creep deformation of the cell walls was also effective in initiating cell wall collapse at a lower pressing pressure. Making much of collapse not only increases density but also increases the mechanical properties of wood. Furthermore, it was found that by controlling the processing parameters (resin content, precuring temperature of resin, pressing temperature and pressing speed) a highly deformed wood at lower pressing pressure could be obtained[3)]. Density and bending strength of 1.1 g/cm^3 and 250 MPa, respectively, were attained at pressing pressure of 2 MPa. These findings indicate that lamination of such materials on the surfaces of the particle mat could produce composites of high performance with moderate density, since untreated wood did not deform well until 3 MPa[2)]. Based on this assumption, this study was aimed at producing high performance veneer/wafer-overlaid particleboard by a combination of plasticization and selective densification of wood.

Materials and Methods

Particles prepared from Japanese cedar (*Cryptomeria japonica*) block using a hammer mill were sieved and particles of 8-mesh (2 mm) path and 16-mesh (1 mm) were used in this experiment. One liquid type isocyanine resin (Gun-ei Chemical Industry, PL4811) diluted with acetone was sprayed as a binder. The moisture content of particle was 12% when acetone was removed. Then low molecular weight phenolic resin (Gun-ei Chemical Industry, average Mn=300, PL2771) impregnated Japanese cedar veneer (1.5 mm in thickness) and wafer (30 mm × 30 mm × 1.5 mm) was overlaid on the surface of the particle mat according to the predetermined weight ratio and compressed at 3 MPa. The pressing temperature was 150°C and pressing time was 30 minutes followed by cooling. The mechanical properties were evaluated using three point bending test over an effective span of 60 mm at a crosshead speed of 10 mm/min.

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Results and Discussion

The density and the mechanical properties of particleboard and phenolic resin (PF) impregnated veneer-overlaid particleboard are shown in Table 1.

From the results, it was obvious that by veneer overlaying MOE and MOR increased significantly. Japanese cedar particleboard of density 0.58 g/cm^3 attained MOE of 1.85 GPa and MOR of 18.1 MPa, respectively, whereas by resin impregnated veneer overlaying, MOE and MOR in the fiber direction of the surface veneer increased about 4.4 times and 4.75 times, respectively, with an increment of density of 10%. Thus, overlaying plasticized veneer on the particle mat before hot pressing is a promising method for improving mechanical properties of particleboard with a slight increase of density.

The mechanical properties of particleboard and wafer-overlaid particleboard are compared in Table 1. The MOR and MOE of wafer overlaid PB were considerably higher than those of PB and the difference was especially

Table 1. Mechanical properties of PF resin impregnated veneer/wafer-overlaid particleboard (PB)

Material	Veneer/wafer ratio in weight	Thick-ness (mm)	Density (g/cm^3)	MOE (GPa)	MOR (MPa)
PB	—	8.6	0.58	1.85	18.1
PF treated veneer overlaid PB	1 : 4 : 1	8.8	0.64	8.19	85.9
Untreated wafer overlaid PB	1 : 3 : 1	9.8	0.60	3.23	25.8
PF treated wafer overlaid PB	1 : 3 : 1	8.7	0.70	6.72	37.3

remarkable in MOE. By overlaying untreated wafer, MOE and MOR of particleboard increased about 40% and 30%, respectively, with a slight increment of density. Furthermore, by overlaying phenolic resin impregnated wafer, the surface became flat and smooth, and MOE and MOR reached 7 GPa and 38 MPa, respectively, about three times and two times higher respectively, than those of Japanese cedar PB, with a density of 0.70 g/cm^3. The MOE of lauan plywood with a density of 0.78 g/cm^3 is reported as 9.7 GPa parallel to surface fiber direction and 5.1 GPa perpendicular to the surface fiber direction.

The MOR in both directions is reported as 73 MPa and 58 MPa, respectively[1)]. Considering the difference in the density between plywood and phenolic resin impregnated wafer-overlaid PB, it could be said that the production of particleboard having similar mechanical properties to plywood is possible by overlaying PF resin impregnated wafer. Further study for obtaining optimum wafer ratio to core particleboard is required.

Conclusions

The production of high performance veneer/wafer-overlaid particleboard was studied. The overlaying veneer plasticized by low molecular weight phenolic resin on the particle mat before hot pressing resulted in selective densification of surface veneer, and improved the mechanical properties of PB significantly with a slight increment in density. Compared to the mechanical properties of the core part, that is Japanese cedar particleboard, the increments in MOE and MOR were 4.4 times and 4.75 times, respectively. When phenolic resin impregnated wafer was overlaid on the surface of particleboard, MOE and MOR attained 7 GPa and 38 MPa respectively.

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